FRUCTIFICATIONS AND FOLIAGE FROM THE MESOZOIC OF SOUTHEAST QUEENSLAND

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Several new fructifications and foliage specimens are described from four sites, in three southeast Queensland Early to Middle Mesozoic basins. This includes *Paraxylopteris* gen. nov., a likely pteridosperm fructification. Discovery of *Paraxylopteris* implies that inclusion of the foliage *Xylopteris* in *Dicroidium* cannot be supported. Pteridosperm remains described from the upper Ipswich Basin include the female fructification, *Umkomasia geminata*, the male fructification, *Pteruchus dubius*, and the foliage *Dicroidium feistmantelii*. It is likely that these remains were from the same plant. Also described are several conifer, cycadalean, equisetalean, lycopod and pteridophyte remains. Sedimentary conditions at the time of preservation are discussed. ❑ *Coniferophyta, Mesozoic, palaeobotany, Pteridophyta, Pteridospermophyta, Queensland.*

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The Triassic and Jurassic floras of Gondwanaland, their habitats, distribution and evolutionary development are not well known and for better understanding detailed knowledge of the fruiting bodies of component species is required. This contribution describes specimens either identified as belonging to new species, or that extend our knowledge of species already described. Specimens have been collected from 4 localities in the Triassic Esk Trough and Ipswich Basin, and the Jurassic Nambour Basin.

The Ipswich Coal Measures contain abundant fossil plants (Jack & Etheridge, 1892; Shirley, 1898; Jones & de Jersey, 1947a). Jones & de Jersey (1947a) divided their study between the Ipswich Coal Measures around the city of Ipswich, and the Brisbane series of the Ipswich Coal Measures, now the Tingalpa Formation (Cranfield et al., 1976). At least one of the study sites of Jones & de Jersey (1947b), within the Brighton Beds near Shorncliffe, was included as part of the Ipswich Coal Measures. It is now assigned to the younger Marburg Formation equivalent in the Nambour Basin (McKellar, 1994). Fossil plants of the Esk Trough have not been extensively studied but previous investigations include those of Walkom (1924, 1928), Holmes (1987), and Rigby (1977). Jones & de Jersey (1947a) compared the Esk Trough and Ipswich Basin floras. The fossil plants of the Nambour Basin have been studied, by Woods (1953), Webb (1980) and Jones & de Jersey (1947b).

LOCALITIES AND GEOLOGY

LOCALITY 1. ESK TROUGH. 152°31'04"E, 27° 18'34"S. (GR523792, Caboolture 1:100 000 sheet area) on the western shore of Wivenhoe Dam, in the Brisbane Valley (Fig. 1B), Esk Formation, Anisian (Murphy et al., 1979).

Jell & Lambkin (1993) described the first insect recorded from the Esk Formation from this site.

The stratigraphy at this outcrop consists of 2 main units, a lower unit comprising fossiliferous shales, sandstones and mudstones concordantly overlain by an upper massive, poorly sorted, matrix supported conglomerate. Sediments appear to be locally derived from the adjacent Palaeozoic blocks. These deposits form part of an alluvial fan complex with finer floodplain and braided steam deposits of the lower unit overlain by the upper conglomerate unit, a likely debris flow.

LOCALITY 2. IPSWICH BASIN, CASTLE HILL. 152°47'59"E, 27°37'50"S. (GR803437, Ipswich 1:100 000 sheet area), east of Ipswich, just south of the suburb of Blackstone, in the Blackstone Formation of Carnian age (Cranfield et al., 1989). This site is on the NNW facing ridge of a hill known locally as Castle Hill, but is referred to by Cameron (1923) and Denmead (1955) as Blackstone Hill (Fig. 1A). The site extends from the top of Thomas Street to the outcropping conglomerate mapped by Staines (1963) as basal Moreton Basin.

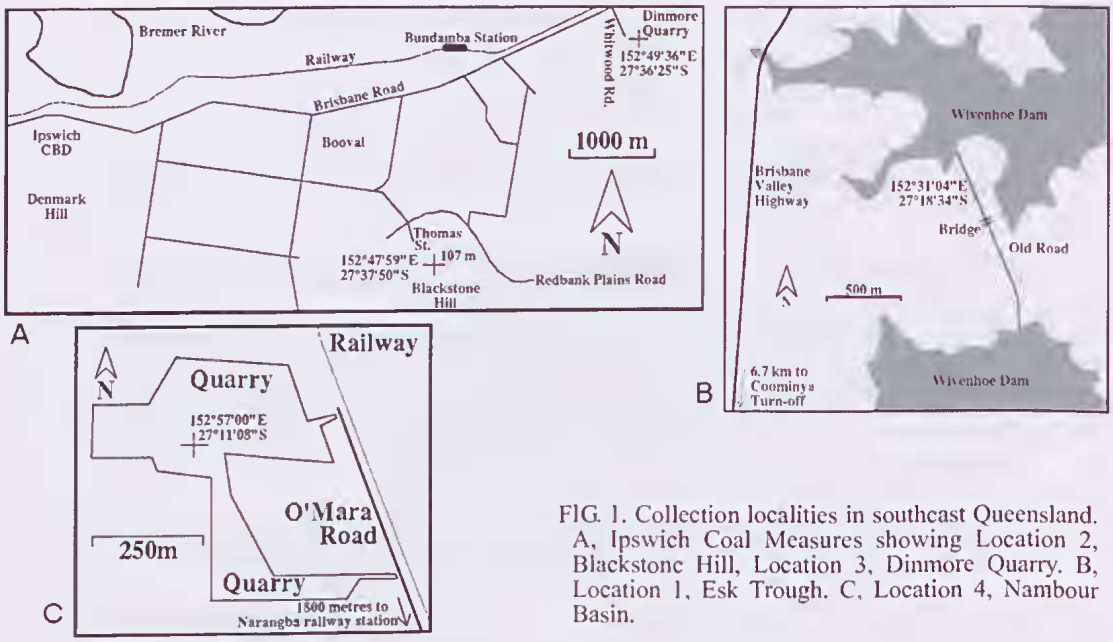

FIG. 1. Collection localities in southeast Queensland. A, Ipswich Coal Measures showing Location 2, Blackstone Hill, Location 3, Dinmore Quarry. B, Location 1, Esk Trough. C, Location 4, Nambour Basin.

Blackstone Hill forms the uppermost preserved sequence of the Blackstone Formation in this area (Cranfield et al., 1976). It is dominantly grey to light brown shale ranging from clayey to sandy and contains numerous laminae of argillaceous sandstone. Shales and minor sandstone beds are generally well indurated, fissile and are commonly fossiliferous. These deposits formed in a slowly aggrading fluvial environment in a distal levee to a proximal flood plain associated with a meandering river.

LOCALITY 3. IPSWICH BASIN, DINMORE QUARRY. A number of fossil leaves and fructifications have been examined from a site east of Ipswich, in the suburb of Dinmore, at 152°49'36"E, 27°36'25"S (GR829463, on the Ipswich 1:100 000 sheet area) (Fig. 1A). This locality is about 3km NNE of Blackstone Hill. There is a fossiliferous Tertiary Redbank Plains Formation outcrop 150 m north of this site, and a mine dump located 100m south contains fossiliferous shale of the Carnian Blackstone Formation (Rigby & Playford, 1988). The second locality is a mixture of strata from a number of horizons so is not significant stratigraphically.

The Dinmore Quarry is a small, shallow excavation with outcropping grey to dark grey fossiliferous shale, which probably represents the uppermost Tivoli Formation (Pattemore, 1998). Freshwater bivalved crustaceans in the shale (Rigby & Playford, 1988), suggest a flood plain lake. Its size and position relative to a fluvial channel is unclear but it received enough fine sediment to promote carbonaceous shale development instead of coal, indicating a not too distal position. More than 70 plant species have been reported from the Quarry in a widely dispersed literature (Tenison-Woods, 1888; Shirley, 1898; Walkom, 1915, 1917a, 1917b; Jones & de Jersey, 1947a; Jacob & Jacob, 1950; Townrow, 1962a, 1962b, 1967; Hill et al., 1965; Herbst, 1974, 1975, 1978, 1979; Webb, 1980, 1982).

LOCALITY 4. NAMBOUR BASIN. 152°57'00"E, 27°11'08"S (GR952929, Caboolture 1:100 000 sheet area), O'Mara Road quarry (Fig. 1C), 2 km NNW of Narangba, 35km NNW of Brisbane.

McKellar (1981a, 1981b, 1994) noted the sediments in the quarry are Toarcian of the uppermost Landsborough Sandstone and correlate with an outcrop of the Brighton Beds, also uppermost Landsborough Sandstone, 15km SE, from where Jones & de Jersey (1947b) described a Jurassic flora. The quarry sediments were deposited in a braided fluvial environment. Our specimens are preserved in an argillaceous sandstone with high clay content. This unit formed as a crevasse splay deposit in a distal levee to proximal flood plain associated with a seasonally large braided river system (Pattemore, 2000). The pteridosperm fructification, *Knezourocarpon narangbaensis* Pattemore, 2000, has been identified from this site.

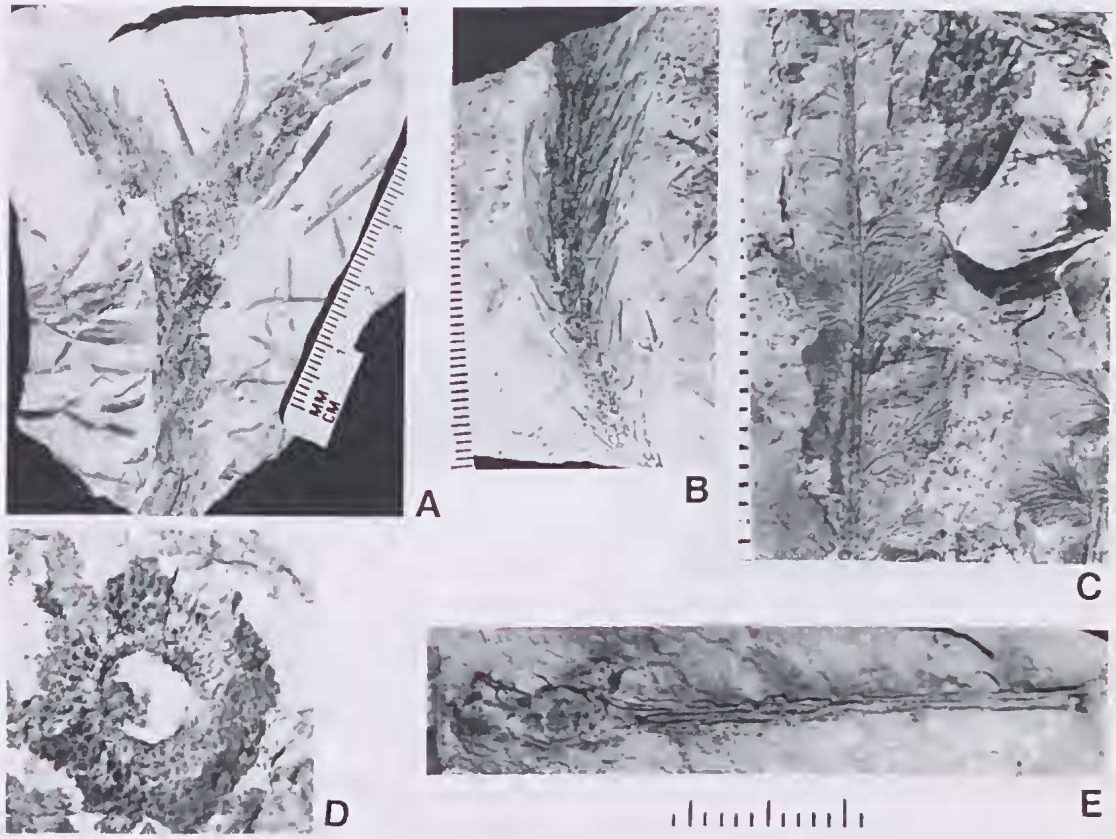

FIG. 2. A, B, Lycopod incertae sedis, Nambour Basin, QMF39298, QMF39267. C, *Lobifolia dejerseya* Retallack, Gould & Runnegar, 1977, QMF42345 (on left), QMF42346 (on right), Esk Trough. D, *Equisetites* sp. A, QMF42341, Esk Trough. E, Equisetalean cone sp. A., QMF42336, Esk Trough. All scales in mm; scale below E applies to D, E.

MATERIAL AND METHODS

Most specimens from the Ipswich and Nambour Basins were collected by R. Knezour. All specimens are in the Queensland Museum (QM). All specimens are preserved as compressions or impressions and unless otherwise stated, have no preserved carbonaceous material.

SYSTEMATIC PALAEOBOTANY

Division LYCOPHYTA
Order LEPIDODENDRALES (unclassified)

Lycopod incertae sedis
(Fig. 2A-B)

MATERIAL. Locality 4, Nambour Basin: QMF39227, 39267 (Fig. 2B), 39269, 39298 (Fig. 2A).

DISCUSSION. Stem fragments clothed thickly with typical strap-like lycopod leaves, maximum 20mm in length, 1.5mm in breadth. They are typical of stem fragments from Palaeozoic arborescent lycopods. *Pleuromeia* is the only genus of arborescent lycopods known from the Mesozoic of Gondwanaland. This genus has a single unbranched trunk. QMF39298 (Fig. 2A) is a fragment of a dichotomously branched lycopod stem, hence our attribution of it to the Palaeozoic Lepidodendrales. We have also seen arborescent lycopod trunk fragments in the Triassic Tingalpa Formation, coeval with the Ipswich Coal Measures, outside our study area, suggesting that SE Qld may have been a refugium for Palaeozoic lycopods well into the Mesozoic.

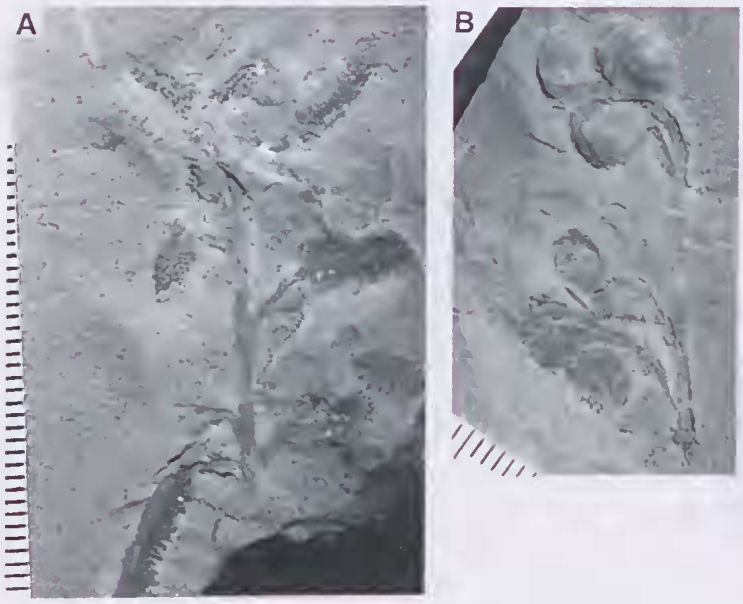

FIG. 3. A, *Pteruchus dubius* Thomas, 1933, emend. Townrow, 1962b, Ipswich Basin, Loc. 2, QMF42568. B, *Umkomasia geminata* (Shirley, 1898) Rigby, In Playford et al. 1982, QMF42544. Scales in mm.

Division SPHENOPHYTA
Order EQUISETALES
Family EQUISETACEAE

Equisetites Sternberg, 1833

TYPE SPECIES. *Equisetites münsteri* Sternberg, 1833.

Equisetites sp. A
(Fig. 2D)

MATERIAL. Locality 1, Esk Trough: QMF42341.

DESCRIPTION. Nodal diaphragm, 14-16mm in diameter, with a hollow centre, 5mm in diameter, surrounded by 1mm wide ring of stem material with a pitted texture, and an outermost ring. The outermost ring with irregular hexagonal mesh pattern coherent for the entire ring, hexagons slightly elongate, 0.5-1.0mm long, and bounded by a toothed margin.

DISCUSSION. The hexagonal mesh pattern, which is the only distinguishing character, may have been superimposed during burial or fossilization. If so, this specimen is identical with diaphragms found in other species which have been defined on other structures, including *Cingularia typica* Weiss, 1876, *Equisetites rotifernm* Tenison-Woods, 1883, *Phyllotheca brookvalensis* Townrow, 1955, *E.* sp. cf. *E. lateralis* Phillips, in Morris, 1845, *E. multidentatus* Ôishi, 1932, *E.* sp. 2, and *E.* sp. 3 (numbered species of Sze et al., 1963). *Equisetites woodsii* Jones & de Jersey, 1947b, has a nodal diaphragm associated with a strobilus featuring hexagonal sporangiophores.

Equisetalean cone sp. A
(Fig. 2E)

MATERIAL. Locality 1, Esk Trough: QMF42336.

DESCRIPTION. Stem 30mm long broadening upwards into an oval shaped structure, 10 × 5mm, having an apparently chaotic internal form, 2mm wide, longitudinally ribbed with 3-4 ridges. Head without ovules or parts readily identifiable as bracts, with a series of irregularly spaced depressions, some with remnants of desiccated sporangial sacs containing small ovoid sporangia grouped into chains. There appears to be 3-4 stalks or leaflets, about 4mm long on top of the head.

COMPARISON. This specimen is similar to *Equisetostachys pendunculatus* Kon'no, 1962, which however lacks the apparent stalks or leaflets at its apex.

Division PTERIDOPHYTA
Order FILICALES
Family DICKSONIACEAE

Lobifolia Rasskazova & Lebedev, in Lebedev & Rasskazova, 1967

TYPE SPECIES. *Lobifolia novopokrovskii* (Prynada, in Vakhrameev & Doludenko, 1962) Rasskazova & Lebedev, in Lebedev & Rasskasova, 1967.

Lobifolia dejerseya Retallack, Gould & Runnegar, 1977
(Fig. 2C)

MATERIAL. Locality 1, Esk Trough: 7 sterile specimens, QMF42345, 42346 (Fig. 2D), 42347, QMF42351 - 42353, 42400, and 4 fertile specimens 42348 - 42350, 42367.

DESCRIPTION. Frond bipinnate with rachis up to 4-5mm wide. Pinnae sub-opposite to alternate, >60mm long with adjacent pinnae about 20mm apart; pinnae rachis 1mm wide reducing to 0.5mm distally, branching from about 70° to almost perpendicular. Rachis longitudinally striated. Pinnules variable in size and shape, sub-opposite to alternate, rounded triangular, inclined to the pinnae rachis at about 50° to nearly perpendicular, 5-(8)-10mm long and 3-(4.5)-6mm wide, closely spaced. Margins generally entire, slightly crenate in places. Pinnule apices pointed, acute to obtuse. Basiscopic margin strongly convex, decurrent at the base; acroscopic margin slightly concave, constricted at the base. Fertile pinnules smaller, apparently borne on a separate frond, stouter and rounder than the sterile pinnules, with many tending toward semi-circular. All other features agree with the sterile pinnules including venation. Pinnae >75mm long; pinnules distally merging to form a pointed acute apex. Fertile pinnules 1.5-(4)-4mm long, 2-(3.5)-4mm wide.

COMPARISON. Despite poor preservation these specimens can be identified as *Lobifolia dejerseya*. *Cladophlebis* sp. A and *Todites* sp. C of Anderson & Anderson (1983) probably also belong in this species.

Division PTERIDOSPERMOPHYTA
Class CORYSTOSPERMALES
Family CORYSTOSPERMACEAE Thomas, 1933

Umkomasia Thomas, 1933

TYPE SPECIES. *Umkomasia macleanii* Thomas, 1933.

Umkomasia geminata (Shirley, 1898) Rigby, in Playford, Rigby & Archibald, 1982
(Fig. 3B)

Beania geminata Shirley, 1898: 16, pl. 20, fig. 1a-e.
gymnospermous seeds, in Walkom, 1917b: 16-17, pl. 20, figs 1-5.
Megasporophyll, in Jones & de Jersey, 1947a: 56, text-fig. 52.
Umkomasia sp. A, in Holmes, 1982: 17, fig. 7G.
Umkomasia geminata Rigby, in Playford et al., 1982: 5, figs 1-3, 7-9.

MATERIAL. Locality 2, Ipswich Basin: 14 specimens, QMF42528 - 42531 and their respective counterparts QMF42532 - 42535, 42536 - 42538, 42540 - 42543, 42544 (Fig. 3B), 42583, 42589 and counterpart 42593.

DESCRIPTION. Panicle, open, with probably irregular branching. Largest specimen incomplete, 130mm long. Cupules numerous, with some incomplete specimens bearing more than 30 cupules. Rachides up to 5mm wide. Branches, up to 40mm long, 2mm wide, each bearing up to 8 cupules arranged oppositely. Cupules, elliptical, 5mm × 4.5mm to 17mm × 11mm, most swollen, suggesting an enclosed ovule, other details unclear. Pedicels up to 1mm wide. Specimen QMF42583 appears to have a juvenile, unfurling frond crozier.

COMPARISON. This collection of specimens includes numerous attached cupules which display much size variation. However, there is little doubt that all these specimens belong to the same species as they are very similar in all other characteristics. Previous descriptions of this species, as listed in the above synonymy are based on fewer specimens and thus it should be expected that more natural variation be found in this larger collection. Some specimens in the present collection are larger than specimens figured previously suggesting previously examined specimens were fragmentary. Anderson & Anderson (2003) figured *Umkomasia* sp. 1, *Umkomasia* sp. 3, and *Umkomasia* sp. 4, all of which appear of similar morphology and size, may also belong in *U. geminata*.

DISCUSSION. This fructification is likely to be associated with the male fructification, *Pteruchus dubius* (discussed below), and the foliage *Dicroidium feistmantelii* (discussed below), which all occurred together at this locality in significant numbers. The liklihood that our attribution of *Dicroidium* to *Umkomasia* follows the discovery in South Victoria Land, Antarctica, of *U. miramia* by Axsmith et al. (2000) attached to fronds of *Dicroidium odontopteroides* (Morris, 1845) Gothan, 1912.

Pteruchus Thomas, 1933, emend. Townrow, 1962b

TYPE SPECIES. *Pteruchus africanus* Thomas, 1933.

Pteruchus dubius Thomas, 1933, emend. Townrow, 1962b
(Fig. 3A)

MATERIAL. Locality 2, Ipswich Basin: 22 specimens, QMF42545, 42547 and counterpart 42576, 42548 and counterpart 42550, 42551, 42553 - 42555, 42557 and

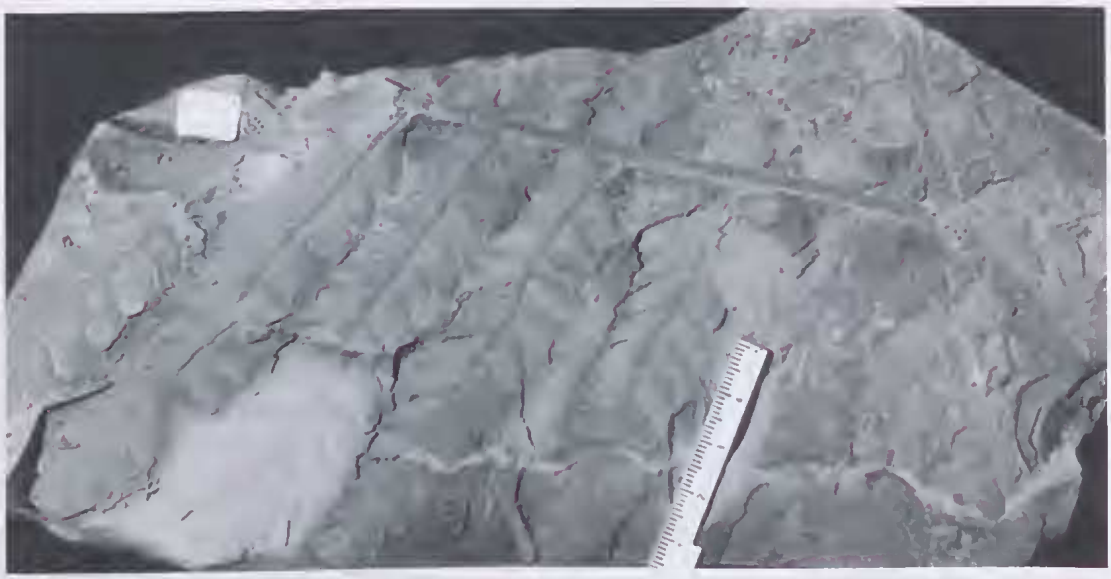

FIG 4. *Dicroidium feistmantelii* (Johnston, 1894) Gothan, 1912, QMF42594, Ipswich Basin, Loc. 2. Scale in mm.

counterpart 42558, 42559 - 42563, 42565 - 42566, 42567 and counterpart 42568 (Fig. 3A), 42569 - 42573, 42574 and counterpart 42575.
Locality 3, Ipswich Basin: 1 specimen held in the private collection of A. Thomson of Brisbane, Queensland.

DESCRIPTION. Fructifications large pinnatafid forming open panicules with rachis up to 150mm long, 4.5mm wide. Pinnules petiolate, with adjacent to sub-opposite branching at 50-80°. Petioles up to 13mm long, 0.5-1.5mm wide. Each pinnule bore a single terminal sporangial head. Some pinnules bifurcate with each branch bearing a head. Some fructifications bore >30 sporangial heads 5-38mm long and 5-8mm wide. Each elliptical to ovate sporangial head bore numerous (>100) pendulous sporangia crowded on the underside of the head. The sporangia are about 2.5mm long, and about 0.5mm wide, but their shape and attachment is unclear. The adaxial surface of each head has a slightly rugose texture and may have been crenate.

DISCUSSION. Specimens of the ovuliferous fructification *Umkomasia geminata* and the foliage *Dicroidium feistmantelii*, which are described herein from Locality 2, are preserved along with *P. dubius* in significant numbers. All of these almost certainly belonged to the same plant.

COMPARISON. These specimens are consistent with *Pterophyllum dubius* as described and figured by Thomas (1933) and Townrow (1962b). A specimen identified as *P.* cf. *africanus* by Jones & de Jersey (1947a: 55) which was discovered near our Locality 2 was referred to *P. dubius* by Townrow (1962b). Some of the studied specimens are larger than those described by Townrow (1962b). The wide range of sporophyll sizes is probably due to a larger number of specimens available and reflects different growth stages, as all other features are similar.

The obscure specimen described as *Calamostachys australis* by Shirley (1898: 25, pl. 18) occurs on the same slab as *Beania geminata* (Shirley, 1898: 16-17, pl. 20) which has since been recombined in *Umkomasia geminata* (Rigby, in Playford et al. 1982). This suggests that *C. australis* may be a poorly preserved *Pterophyllum* sp.

Dicroidium Gothan, 1912, emend. Townrow, 1957

TYPE SPECIES. *Dicroidium odontopteroides* (Morris, 1845) Gothan, 1912.

DISCUSSION. The species of this genus are highly variable in form, as illustrated by Retallack (1977) and Anderson & Anderson (1983). These authors have in different ways, developed nomenclatural systems that attempt to cater for this variability. However, several of the names proposed by these authors are invalid with respect to the International Code of Botanical Nomenclature. Given this, for the purposes of this work, the nomenclature of these authors is not used. This is not to suggest that the general

thrust of the various arguments presented by these authors is of no value.

Anderson & Anderson (1983) suggested *Dicroidium* was a plant with a reticulate evolutionary history, which freely hybridised across Gondwanaland. They illustrated aberrant specimens of *Dicroidium* as evidence of hybridisation between two populations at one site, Birds River, South Africa. This appears to be the only site in Gondwanaland currently known with a strong suggestion of hybridisation. Aberrant fronds are rare elsewhere and are generally attributed to deformities because of physical damage. The issue of variability in *Dicroidium* species and the reasons for this requires further examination in the light of the work by Jacob & Jacob (1950) who showed that preserved cuticle of *Dicroidium* fronds from the Ipswich area implied the presence of more species than is suggested by megascopic frond morphology.

Our specimens have considerable morphological variation. They do not have preserved cuticle, which has been demonstrated as important consideration (Jacob & Jacob, 1950) when examining boundaries or continua between species.

Dicroidium feistmantelii (Johnston, 1894) Gothan, 1912
(Fig. 4)

MATERIAL. Location 2, Ipswich Basin - 16 specimens, QMF42539, 42546, 42549, 42552, 42556, 42564, 42577 - 42582, 42585 and counterpart 42586, 42588 and counterpart 42592, 42590, 42594 (Fig. 4).

DISCUSSION. Our specimens are conspecific with *D. feistmantelii* as described and/or figured by Gothan (1912), Antevs (1914), Jacob & Jacob (1950), Hill et al. (1965), Jain & Delevoryas (1967) and Rigby (1977). They are also indistinguishable from *Zuberia feistmantelii* (Johnston, 1894) Frenguelli, 1944 as figured by Frenguelli (1944), and *Thinnfeldia feistmantelii* Johnston, 1894, by Johnston (1894, 1896) and by Walkom (1917a, pl. 2, fig. 2; 1924, pl. 17, fig. 1F). Our specimens are preserved together with *Umkomasia geminata* and *Pteruchus dubius*, which are likely to be the ovuliferous and microsporangiate fructifications respectively, associated with this foliage.

Xylopteris Frenguelli, 1943

TYPE SPECIES. *Xylopteris elongata* Frenguelli, 1943.

Xylopteris argentina (Kurtz, 1921) Frenguelli, 1943
(Fig. 5B)

MATERIAL. Location 3, Ipswich Basin: 35 specimens, QMF42405 - 42413, 42420 - 42423, 42426 and counterpart 42510, 42494 - 42500, 42502 - 42505, 42511 - 42514, 42518 (Fig. 5B), 42519 - 42523.

DESCRIPTION. Frond pinnate, with a leaf-like rachis, 1.5-2mm wide, which bifurcates once, occasionally twice, more or less symmetrically, at <25°. Pinnules apparently borne only on the ultimate segments of the rachis, narrowly linear, margins entire, apex acute, pointed, up to 70mm long, 0.5-1.5mm wide, with a faint median vein.

DISCUSSION. The strap-like rachides are similar to *Sphenobaiera pontifolia* Anderson & Anderson, 1989, but are distinguished by their distally borne pinnules. Townrow (1962a) described 2 specimens of *X. elongata* (Carruthers, 1872) Frenguelli, 1943, from the Ipswich Coal Measures, which had smaller and more numerous branches positioned over the entire length of their rachides. No carbonaceous material was preserved in any of the specimens examined herein. Our specimens are consistent with *X. argentina* of Retallack (1977), and *Dicroidium elongatum* var. *argentina* (Kurtz, 1921) Anderson & Anderson, 1983. The later combination may be untenable given the likely male fructification associated with *X. argentina* foliage, *Paraxylopteris queenslandensis* gen. et sp. nov. (described below), which, if attached, would preclude the combination of *Xylopteris* in *Dicroidium*.

Xylopteris spinifolia (Tenison-Woods, 1883) Frenguelli, 1943
(Fig. 5A)

MATERIAL. Location 2, Ipswich Basin: 3 specimens, QMF42584 and counterpart 42587, 42591 (Fig. 5A).

DESCRIPTION. Frond bipinnate, up to 130mm long, with bifurcating rachides up to 3mm wide. Pinnae, up to 40mm long, branching at about 50°. Opposite to sub-opposite pinnules, up to 13mm long, branching at about 30°, with a distinct median vein. Pinnae have three or fewer pinnules per side of the pinnae midrib.

COMPARISON. These specimens compare well with specimens of this species described and figured by Frenguelli (1943), Hill et al. (1965) and Retallack (1977).

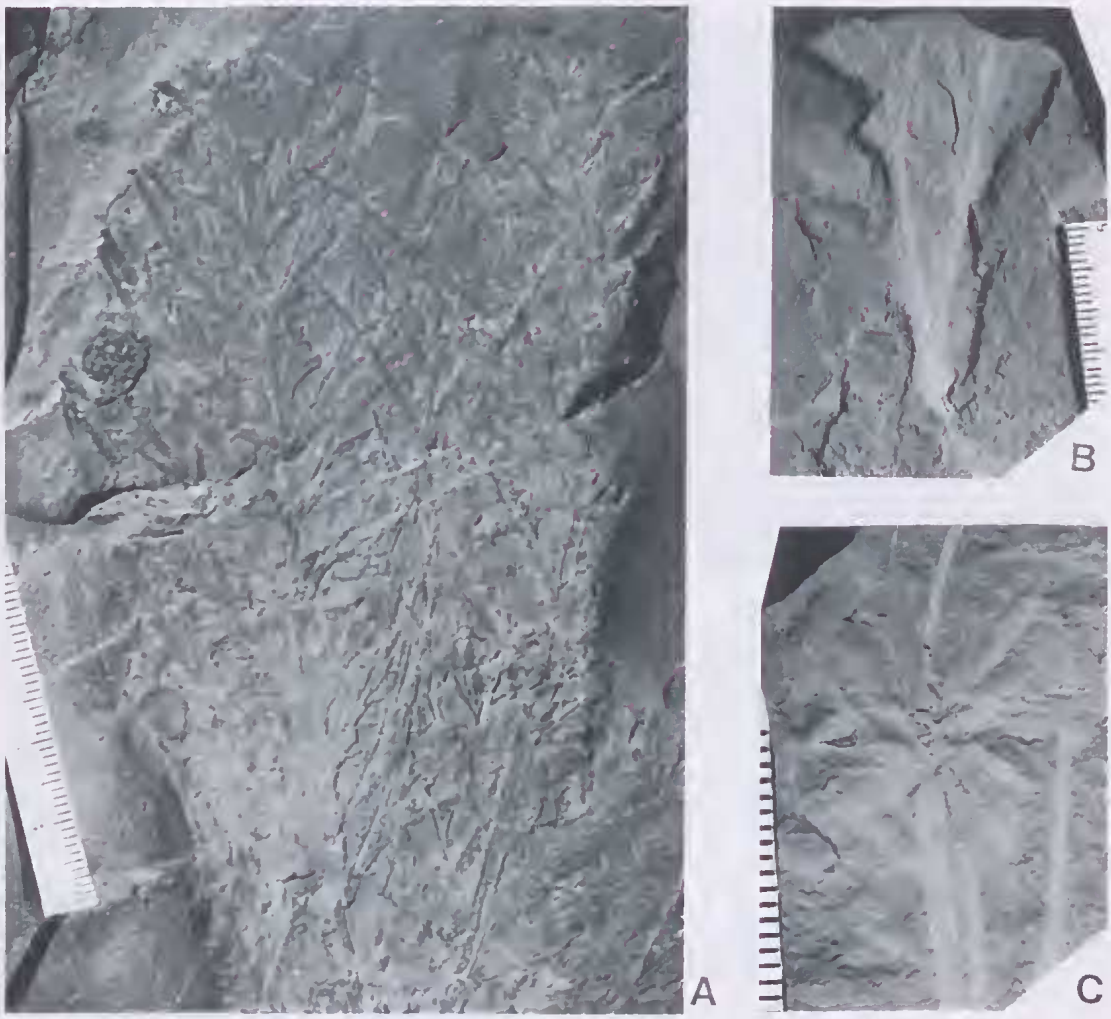

FIG. 5. A, *Xylopteris spinifolia* (Tenison-Woods, 1883) Frenguelli, 1943, QMF42591, Ipswich Basin, Loc. 2. B, *Xylopteris argentina* (Kurtz, 1921) Frenguelli, 1943, QMF42518, Ipswich Basin, Loc. 3. C, *Antevsia extans* (Frenguellli, 1944) Townrow, 1960, Ipswich Basin, Loc. 3. All scales in mm.

Paraxylopteris queenslandensis gen. et sp. nov. (Fig. 6)

MATERIAL. Locality 3, Ipswich Basin: 1 specimen (holotype), QMF42425.

ETYMOLOGY. The generic name refers to the specimen's similarity with *Xylopteris*, while the specific name refers to Queensland, the Australian State in which it was discovered.

DIAGNOSIS. Genus monotypic. Frond pinnate consisting of a long strap-like rachis and strap-like pinnules. Sterile pinnules are grouped basally and branch probably sub-alternately. Strobulus terminal on rachis, elongate and slightly ovate. Within the strobilus, and forming the basic structure of the strobilus, the rachis thrice bifurcates (or branches) and gives rise to numerous small, probably bilateral branches, each of which bore several very small pendulous(?) sporangia.

DESCRIPTION. Pinnate frond segment, 70mm long, consisting of a leaf-like rachis, 1.5mm wide, with four bilaterally branched pinnules, grouped about 40mm from the likely terminal strobilus. Slightly ovate strobilus, 21mm long and 7-9mm wide. The strap-like rachis bifurcates or branches at a very acute angle three times within the fertile section of the pinnae. Sporangia are preserved in a very crowded and confused

FIG. 6. *Paraxylopteris queenslandensis* gen. et sp. nov. Holotype: A, part, QMF42425; B, counterpart, QMF42415, Ipswich Basin, Loc. 3. Scales in mm.

manner but appear to consist of numerous very small branches up to 9mm long, branching probably bilaterally from the strap-like rachis at about 30°. Details of these small branches are unclear but they appear to have been delicate bearing several very fine, hair-like pollen sacs probably pendulously.

COMPARISON. The general form of these specimens is remarkably similar to the foliage *Xylopteris argentina* (Kurtz, 1921) Frenguelli, 1943, discussed above, which is abundant at this site. It seems very likely that these specimens are the male fructifications of this species, given their very similar morphology of the sterile pinnae and that they occur at the same locality.

This specimen varies considerably from *Pteruchus* as diagnosed by Townrow (1962b). It had a considerably less robust structure than *Pteruchus*, with the stobilus probably forming part of an otherwise vegetative frond. Unlike *Pteruchus*, which had a well developed sporophyll head (or bract) beneath which sporangial material was attached, the rachis in this specimen appears to have formed the sporophyll head. Given this apparently less well developed fructification it seems possible that this specimen represents an evolutionary point between more developed pteridosperms and the pteridophytes. If these fructifications were attached to *Xylopteris* foliage then this precludes the combination of *Xylopteris* into *Dicroidium* by Anderson & Anderson (1983).

PELTASPERMACEAE
Thomas, 1933

Antevsia Harris, 1937

TYPE SPECIES. *Antevsia zeilleri* (Nathorst, 1908) Harris, 1937.

Antevsia extans (Frenguelli, 1944) Townrow, 1960
(Fig. 5C)

MATERIAL. Locality 3, Ipswich Basin: 12 specimens, QMF42402 - 42404, 42424 (Fig. 5C), 42493, 42501, 42506 - 42509, 42526 - 42527.

DESCRIPTION. Sporangia symmetrical, four-lobed, peltate borne terminally on a short pedicel about 7mm long and about 0.5mm wide. The complete fructification probably bore around 12 such sporangia branched from a stem in an unclear arrangement. The pedicel was attached centrally to the structure with four lobes radiating from this central point, lobes elongate and slightly obovate, 6-(8)-10mm long and 2.5-3mm wide, with pointed bases and apices.

COMPARISON. These specimens are almost certainly the same as those described and figured by Walkom (1915: 31, pl. 3, figs 3-4) as equisetaceous tubers. This author believed the pedicel to be a root, however these specimens clearly show sporangia mounted terminally on a pedicel branching from a stem. Townrow (1960) combines these 'equisetaceous tubers' in *A. extans* and his description and figures of this species compare well with the specimens described herein. *Antevsia* sp. A of Anderson & Anderson (1983, pl. 23, figs 3-4) from the Molteno Formation of the Karoo Basin, South Africa, probably also belongs in *A. extans*.

DISCUSSION. The shape of the sporangial material, which probably had an almost circular cross-section before compression, is more indicative of a dehiscing pollen sac. There is also the possibility that these specimens were cupules which encapsulated a large seed. Only one large seed was identified with these specimens, Pteridosperm seed sp. A (Pattemore, 1998: 98, QMF42492), but its size and shape renders this interpretation most unlikely. No seeds of this size were identified in any of the studied material, nor have they been described in the literature concerned with the Carnian sediments of southeast Queensland.

Townrow (1960) refered *A. extans*, the foliage, *Lepidopteris stormbergensis* (Seward, 1903) Townrow, 1956, and the ovuliferous fructification, *Peltaspermum thomasii* Harris, 1937 to the same plant. Some fragmentary foliage, which were possibly referable *L. stormbergensis*, were also found with the studied *A. extans* specimens (Pattemore, 1998: 95, QMF42427 and counterpart 42517). These fructifications are numerous and are found along with many specimens of *Xylopteris argentina* and a specimen of *Paraxylopteris queenslandensis* gen. et sp. nov., but there is no observed physical connection between these specimens.

CYCADOPHYTA
Genera of Uncertain Family

Nilssonia Brongniart, 1825

TYPE SPECIES. *Nilssonia brevis* Brongniart, 1825.

Nilssonia eskensis Walkom, 1928

DISCUSSION. Anderson & Anderson (1989) elected not to employ *Nilssonia* and questionably combined *N. eskensis* from the Esk Trough into *Halleyoctenis multilineata* (Shirley, 1898) Anderson & Anderson, 1989, which includes specimens with pinnule attachment ranging from lateral to slightly dorsal. The specimen as described and figured by Walkom (1928) has pinnules attached to the upper surface of the rachis (strongly dorsally). We consider the removal of this species to another genus to be inappropriate.

Pterophyllum Brongniart, 1828

TYPE SPECIES. *Pterophyllum longifolium* Brongniart, 1828.

Pterophyllum multilineatum Shirley, 1898

DISCUSSION. This species known from the Ipswich Basin, with laterally attached pinnae typically found in modern cycads, was combined into *Halleyoctenis multilineata* (Shirley, 1898) Anderson & Anderson, 1989 and grouped with *Nilssonia* specimens which had dorsally attached pinnae as in *Nilssonia eskensis*. This combination is questioned on the grounds that lateral and dorsal pinnae attachment is of at least generic significance consistent with the description and figures of *P. multilineatum* of Shirley (1898) and Walkom (1917b).

Yabeiella Ôishi, 1931

TYPE SPECIES. *Yabeiella brackebuschiana* (Kurtz, 1921) Ôishi, 1931

Yabeiella marcyesiaca (Geinitz, 1876) Ôishi, 1931 (Fig. 7A,E)

MATERIAL. Locality. 3, Ipswich Basin: 1 specimen, QMF42525 (Fig. 7A, E).

DESCRIPTION. Leaf, narrowly elliptical, margin entire, 160mm long, up to 28mm wide with a prominent midrib, 2.5mm wide basally and tapering to 1.5mm wide distally, lamina attached laterally to the midrib. Veins curve arcuately from the midrib then extend across the lamina at 70° without curvature, bifurcating, coalescing and rarely anastomosing, curving into a marginal vein distally. Most bifurcation and coalescence of veins occurs near the midrib or marginal vein. Venation density, 18 veins per 10mm. Marginal vein prominent about 0.8mm wide.

DISCUSSION. Our specimen is identical with specimens figured by Geinitz (1876) as *Taeniopteris mareyesiaca*, Walkom (1917a) as *Taeniopteris dunstanii*, both Jones & de Jersey (1947a) and Anderson & Anderson (1989) as *Y. mareyesiaca*. Webb (1980) identified this species from the Esk Trough.

Linguifolium Arber, 1917, emend. Retallack, 1980

TYPE SPECIES. *Linguifolium lillieanum* Arber, 1917

Linguifolium tenison-woodsii (Etheridge, in Jack & Etheridge, 1892) Retallack, 1980 (Fig. 7C,D)

Angiopteridium ensis Oldham, in Tenison-Woods, 1883: 119.
Angiopteridium tenison-woodsii Etheridge, in Jack & Etheridge, 1892: 375.
Taeniopteris tenison-woodsii; Shirley, 1898: 23, pl. 9, fig. 2.
Taeniopteris tenison-woodsii; Walkom, 1917b: 32-34.
Linguifolium tenison-woodsii; Retallack, 1980: 50-51, fig. 7F-H.

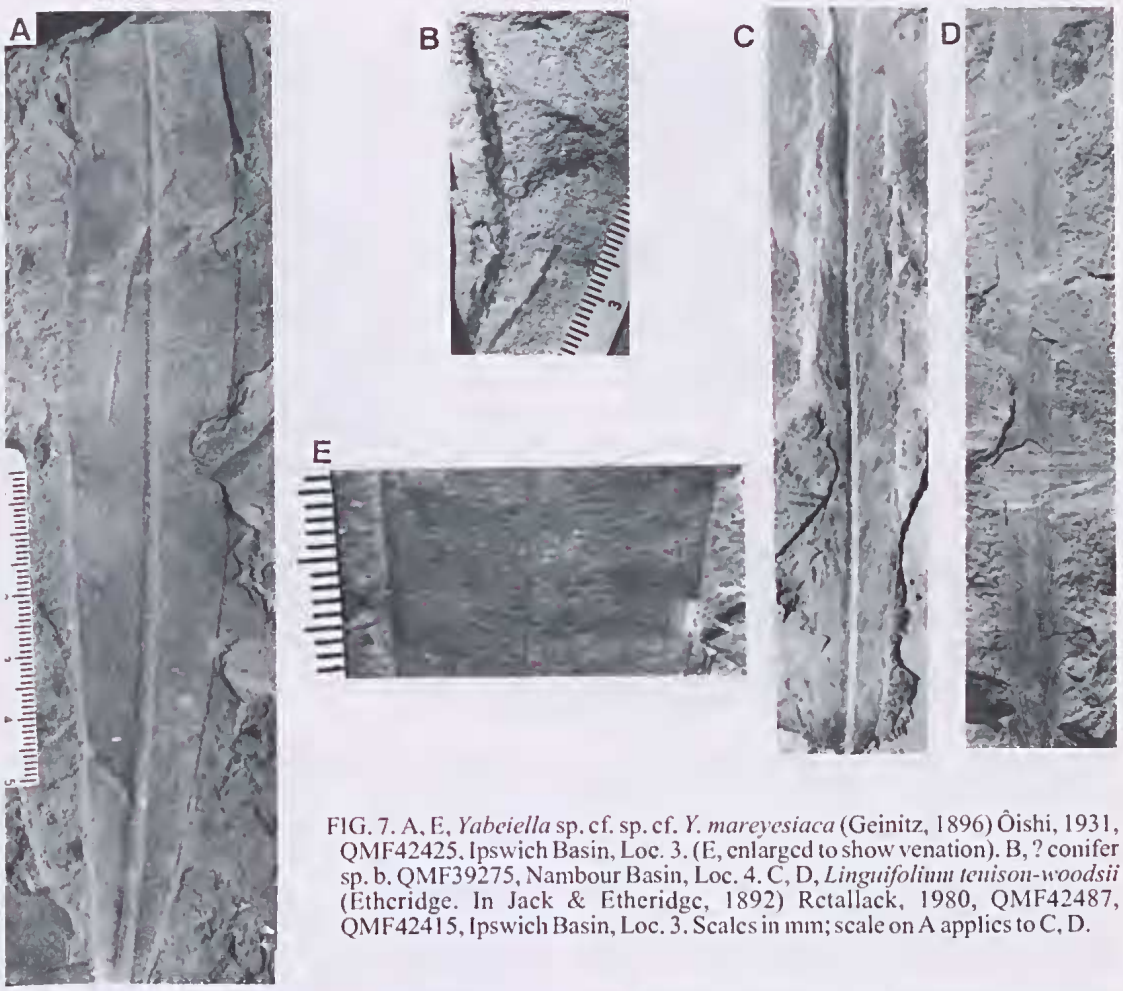

FIG. 7. A, E, *Yabeiella* sp. cf. sp. cf. *Y. mareyesiaca* (Geinitz, 1896) Ôishi, 1931, QMF42425, Ipswich Basin, Loc. 3. (E, enlarged to show venation). B, ? conifer sp. b. QMF39275, Nambour Basin, Loc. 4. C, D, *Linguifolium tenison-woodsii* (Etheridge. In Jack & Etheridge, 1892) Retallack, 1980, QMF42487, QMF42415, Ipswich Basin, Loc. 3. Scales in mm; scale on A applies to C, D.

The synonymy lists only citations necessary for the identification of the species. The Indian species described as *Stengerites ensis* Oldham, in Oldham & Morris, 1863 was later used, but not recombined as *Taeniopteris ensis* by Feistmantel (1876). Feistmantel (1877) recombined Oldham's specimens into *Angiopteridium ensis*. Tenison-Woods (1883) identified a specimen as *Angiopteridium ensis* which Etheridge (in Jack & Etheridge, 1892) recognised as differing from the Indian species, and named it *Angiopteridium tenison-woodsii*. Shirley (1898) recombined, described and figured for the first time, the Australian species as *Taeniopteris tenison-woodsii*. Arber (1913) subsequently erected the genus *Linguifolium*, which was used by Retallack (1980).

MATERIAL. Locality 3, Ipswich Basin: 8 specimens, QMF42415 (Fig. 7D), 42616 - 42418, 42487 (Fig. 7C), 42488, 42489, 42524.

DESCRIPTION. Leaf narrowly linear, 7mm wide, with the largest incomplete specimen 65mm long, margin entire, midrib prominent, longitudinally striated, about 0.8mm wide, with lamina laterally attached. Neither leaf apices nor bases are preserved. Veins branch from the midrib at 20°-40°, simple or once forked, recurving slightly to terminate at the margin at a slightly more acute to slightly less acute angle than that made with the midrib, in places the angle between the venation and the margin is so acute as to appear to be almost forming a marginal vein. Venation density varies considerably between specimens from 6-16 veins per 10mm.

DISCUSSION. Specimens vary considerably both in terms of venation density and geometry. Most specimens are identical with: *Taeniopteris tenison-woodsii* (Etheridge, in Jack and Etheridge, 1892) Walkom, 1917a as described by Walkom (1917a, 1928); *Doratophyllum tenison-woodsii* (Etheridge, in Jack & Etheridge

1892) Jones & de Jersey 1947a; and *Linguifolium tenison-woodsii* as figured by Retallack (1980) also Anderson & Anderson (1989). Venation in some specimens ranges to identical with that of *L. gracile* Anderson & Anderson, 1989. Given the venation density and geometrical variation in the specimens examined herein, *L. gracile* is a junior synonym of *L. tenison-woodsii*.

Zamites Brongniart, 1828

TYPE SPECIES. *Zamites gigas* (Lindley & Hutton, 1834) Morris, 1843.

Zamites queenslandi (Walkom, 1917b) Webb, ex Anderson & Anderson, 1989 (Fig. 8A)

MATERIAL. Locality 1, Esk Trough: 8 specimens, QMF42338, 42339 and its counterpart 42340 (Fig. 8B), 42381 - 42383, 42386 - 42388.

DESCRIPTION. Frond pinnate, >85mm long, >20mm wide, rachis 1-1.8mm wide. Pinnae slightly oblanceolate to elliptical, 6-13mm long, 3.5-4mm wide distally, 2.5-3.5mm wide near base, attached dorsally, extending from the rachis at 70-90°, closely spaced but not overlapping; most pinnae broaden distally and have slightly bulbous bases. Venation dense, approximately 5 veins per mm, dichotomising, slightly divergent.

DISCUSSION. Webb (1980) referred *Otozamites queenslandi* Walkom, 1917b to *Z. queenslandi* on the ground that pinnules had poorly developed auriculate bases. This view of the difference between *Zamites* and *Otozamites* is consistent with Seward (1969), and Taylor & Taylor (1993). Anderson & Anderson (1989) formalised the combination with *Zamites*.

Division CONIFEROPHYTA
Order CONIFERALES
Family VOLTZIACEAE

Heidiphyllum Retallack, 1981

TYPE SPECIES. *Heidiphyllum elongatum* (Morris, 1845) Retallack, 1981.

Heidiphyllum sp. cf. **H. elongatum** (Morris, 1845) Retallack, 1981

MATERIAL. Locality 1, Esk Trough: 5 specimens, QMF42332 - 42335, 42337. Locality 3, Ipswich Basin: 1 specimen, QMF42419 (?).

DESCRIPTION. Leaves linear oblanceolate, some slightly falcate, length 30-100mm, all specimens incomplete, width up to 10mm, constricting abruptly distally to form a rounded acute apex, narrowing to about 2mm at their sessile base, margins entire, veins dichotomous and parallel for most of their course but converge slightly toward the apex terminating at the apical margin. Veins evenly spaced with a density of 1-2 per mm. Some veins may merge in the apical region close to the apical margin.

DISCUSSION. Specimens are not well preserved but they conform with the description of Anderson & Anderson (1989). Specimens of *Phoenicopsis elongatus* Morris, 1845, as described by Walkom (1917b, 1924) and Hill et al. (1965), probably belong here. Our specimens are compared with the species as they are fragmentary and it is possible that some of these fragments could be ginkgoalean foliage, but the very few visible apices and bases of our, and Pattemore's (1998) specimens are indicative of *Heidiphyllum*. One fragmentary specimen from Locality 3, Ipswich Basin, is tentatively referred here.

Family PODOCARPACEAE

Rissikia Townrow, 1967

TYPE SPECIES. *Rissikia media* (Tenison-Woods, 1883) Townrow, 1967.

Rissikia sp. cf. **R. apiculata** Townrow, 1967 (Fig. 8D)

MATERIAL. Locality 4, Nambour Basin: QMF39268, 39270.

DESCRIPTION. Foliage fragments poorly preserved with stem thickness up to 1mm, shoot length up to 50mm. Specimen QMF39268 has branched shoots apparently incomplete, 10mm long, shoot branching arrangement unclear. Leaves linear, inserted spirally 5-8mm long, <1mm wide, 1.5-2mm between leaves, bases slightly decurrent, no or minimal leaf-width contraction basally. Leaves covering the entire length of each fragment, branched acutely, recurved away from the stem. Cross-sectional detail unclear, leaf thickness probably <1mm.

COMPARISON. Specimens are consistent in features with *Rissikia* as diagnosed by Townrow (1967). The description of specimens of *Elatocladus* Halle, 1913, by Townrow (1967: 131), includes shoots with laterally ranked petiolate leaves. *Elatocladus* includes foliage with petiolate leaves or leaves with distinctly constricted bases (Seward, 1969; Anderson & Anderson, 1989: 450), whereas *Rissikia* has no or minimal leaf base contraction (Townrow, 1967: 103). The specimens described herein do not exhibit bilaterally ranked leaves and appear to have only

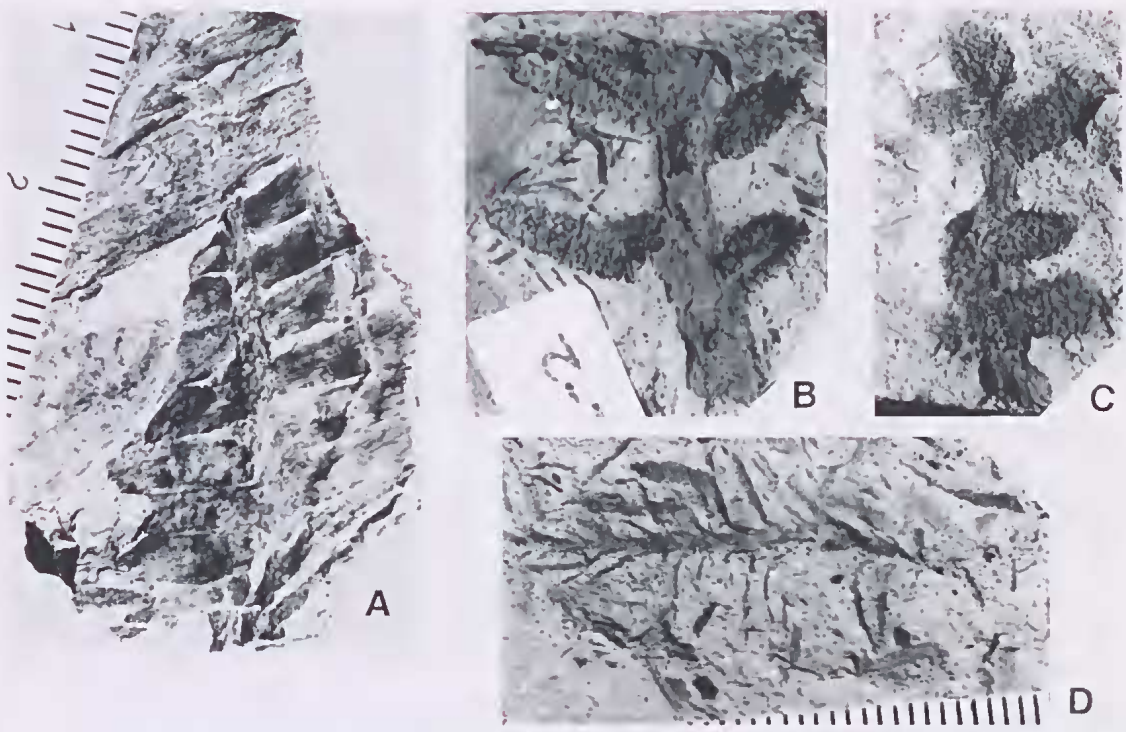

FIG. 8. A, *Zamites queenslandi* (Walkom, 1917b) Webb, ex Anderson & Anderson, 1989, QMF42340, Esk Trough, Loc. 1. B,C, conifer cone sp. a, QMF39278, QMF39279, Nambour Basin, Loc. 4. D, *Rissikia* sp. cf. *R. apiculata* Townrow, 1967, QMF39270, Nambour Basin, Loc. 4. Scales in mm; scale on D applies to B-D.

minimal (if any) leaf base contraction. In these and other features they are most similar to *R. apiculata* but differ in the diagnosed leaf spacing for this species, namely 5mm (Townrow, 1967: 113), and the branching shoots. Townrow (1967: 119) does not include branched shoots in *Rissikia* although this is not included as a diagnostic feature of the genus. *Mataia* Townrow, 1967, does include branched shoots however *Mataia* leaves are diagnosed as thin and fragile, and although spirally mounted, they twist at the base to form into two rows. The specimens examined herein do not show any such tendency.

CONIFERALES incertae sedis

conifer cone sp. a
(Fig. 8B, C)

'Obscure? Fructifications', in Arber, 1917: 65, pl. 13, figs 2,3,5,6.

MATERIAL. Locality 4, Nambour Basin: 28 specimens, QMF39228, 39230, 39234, 39235, 39247, 39256, 39261, 39278 (Fig. 8B), 39279 (Fig. 8C), 39280 - 39283, 39285, 39291 - 39294, 39312 - 39313, 42595 - 42596, 42610.

DESCRIPTION. Probable male fructification, appears bipinnate and leafless, with several, small, ellipsoidal, sessile, and apparently woody cones. Cones up to 12mm long, 5mm wide, branching at 70-90° from an apparently leafless stem. Stems have a compressed diameter of up to 9mm, and appear to have been bipinnate, with an unknown branching arrangement for primary and secondary stems. Cones grew on both primary and secondary stems in what was probably an irregular spiral arrangement. Ultimate shoots have a terminally mounted cone (Fig. 8C). Some cones appear to have been clustered with a few cones branching at a single node. Bracts, 1.5-2mm long, 0.8-1mm wide, were spirally arranged and branch acutely from a thick central core 1.5-3mm wide. The shape of the bracts is unclear and preservation is too poor to describe sporangial material.

COMPARISON. Male cones identified as 'obscure? Fructifications' by Arber (1917) and listed herein as synonymous, are smaller, but otherwise are identical.

Rissikia is based on foliage, male and female fructifications, pollen and cuticle. Our specimens are similar in size and form with the male cones of *Rissikia*, however the bipinnate branching structure on which they grew is unlike that of *Rissikia*. They are, however, preserved together in significant numbers with *Rissikia* sp. cf. *R. apiculata* (see above), and with the exception of the below mentioned possible female cone, they are the only two conifer-like plant remains in a sedimentary horizon containing abundant plant remains. Given the significant difference of the bipinnate branching and the lack of preserved cuticle in our specimens, they cannot be referred to an existing or new species of *Rissikia*. Additionally, given the closely packed bracts it seems unlikely that these cones could be interpreted as the leaf bases of vegetative short shoots. Further, the primary and secondary stems show no evidence of leaf scars.

?conifer sp. b
(Fig. 7B)

MATERIAL. Locality 4, Nambour Basin: 5 specimens, QMF39274 and counterpart 39275 (Fig. 7B), 39295 - 39297, 39306.

DESCRIPTION. Specimens are narrowly linear, up to 55mm long, 3mm wide, with unknown attachment. One specimen and possibly a second were branched. Obovate, spirally attached bracts, about 2mm long, <1.5mm wide. Leaves/bracts were adpressed to or very acutely branched from a thin central stalk and appear to be slightly domed away from the stem axis. No seeds were positively identified within the structure or nearby to the specimen.

DISCUSSION. Specimens are very poorly preserved. These occur along with the foliage and likely male conifer cone, 'conifer cone sp. A'(discussed above). In available features, they appear most like the ovuliferous cones of *Rissikia*, with the exception of their branching. If seeds were identified with these, their likely association with the above conifer specimens would have to be considered.

Arber (1917: 60-61, pl. 8, fig. 1) identified a specimens as *Pagiophyllum peregrinum* Lindley & Hutton, 1833, from the mid-Mesozoic of the South Island, New Zealand, which appear similar but had thicker stems than our specimens.

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